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TITLE OF INVENTION

Title of Invention is: " Raw Influent Treatment Processes Eliminating Secondary Biological Treatment "

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CROSS -REFERENCE TO RELATED APPLICATIONS

"Not Applicable"

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

"Not Applicable"

REFERENCE TO A MICROFICHE APPENDIX

"Not Applicable"

BACKGROUND OF THE INVENTION

1. *Field of Invention*

This invention relates to paper making processes , pulping mills and manufacture at fully integrated pulp and paper mills and to raw influent treatment processes for reducing Chemical Oxygen Demand , Total Organic Carbon , and Color in these raw influent streams in production of pulp and paper ; and it does have other applicability to other industrial and municipal POTW influent treatment . Secondary biological treatment is eliminated.

2. *Description of Prior Art*

Large amounts of water are used in various stages of the pulping , bleach plant , and papermaking processes. At the DeRidder , Louisiana , mill of Boise Cascade where I was Corporate Environmental Engineer the average raw influent wastewater flow was 30 million gallons per day. The paper making processes such as at Boise's mill included bark removal , pulping digesters, chlorine ,hypochlorite , and caustic extraction operations in bleach plant , three combination power boilers, chemical recovery boiler, lime kiln groundwood , and thermomechanical pulping. Boise's DeRidder , Louisiana , mill discharged an average of 30 to 37.5 million gallons per day of wastewater to a small low flow stream Anacoco Bayou .

The raw influent wastewater stream 1 is contaminated with lignins , lignin degradation products , humic acids , and sulphates(ites) attached to ring structures , cellulose fibers , cooking chemicals and like . These contaminants make the effluent stream dark colored and are often referred to as color bodies. Since pulp and paper mills produce large quantities of this densely -colored raw influent , the discharge of this effluent into adjacent streams and bodies of water causes an objectionable discoloration of the water. Table 2 is actual tabulation from South Carolina Department of Health and Environmental Control actual files for wastewater discharges of Bowater at Catawba , S. C. , and International Paper at Georgetown , S. C. ; their discharges to the stream were 2820 milligrams per liter and 1783 milligrams per liter of Color respectively. But there is even

a larger problem as inventor discovered that there is no biological degradation . That since pulp and paper mill operations results in configuring a negative electrical charge on the lignins, and other organic ringed compounds , it is these electrical charges that are measured by the Biochemical Oxygen Demand (BOD) test . No biological degradation takes place. Of the approximately 700 to 950 integrated pulp and paper mills in the United States of America none add chemicals at primaryclarifier . Since the industry has convinced EPA that it is too expensive to add chemicals for Color removal only biological secondary aeration treatment is practiced. However falsehood and environmental detriment is that actually "no biological degradation takes place in the secondary biological systems , and there are no bugs degrading any materials " . In 1985 the Best Available Control Technology (BACT) in Clean Water Act , Public Law 92-500 , and National Pollutant Discharge Elimination System (NPDES) effluent guidelines had Color limits of 200 to 250 milligrams per liter concentration limits for Color. These proposed Color limits were eventually deleted! This invention brings the truth to realm and reality which is that there is really no biological degradation being performed in biological lagoons . Additionally , when this becomes fully vamped into public domain and at EPA 's leadership and industry's leadership , everyone wins as industry will have immediately more expansion capacity capability at all their operating plants and will save tremendous amounts of money . Furthermore , streams accepting the industries' wastewater will have extremely more assimilative capacity to accept wastes and protect human health and aquatic life.

Figure 1 is a schematic representation of a typical integrated pulp and paper plant' s waste water treatment system , typical for Boise's DeRidder , Louisiana , mill . The raw influent stream1 is main influent sewer entering the primaryclarifier . In all mills nationwide no chemicals are added and only gravity settling is utilized . The average pH of raw influent is in range of 7.5 to 8.5 ; and this was true for Boise's DeRidder raw influent . Various processes have been proposed fordecolorization at this stage ; however all other state of art dictate that biological secondary treatment is additionally required . This invention eliminates the secondary biological treatment which is discussed in detail later. Additionally, all other prior art is not aware that no biological degradation takes place . In existing United States 950 pulp and paper mills where no chemicals are added at primaryclarifiers , there is no change , no reduction in the Chemical Oxygen Demand , Total Organic Carbon , and Color across theclarifier and aerated secondary biological system. That all other "old art" were not aware that there was never, ever any biological degradation , destruction in secondary biological systems.

As in Fuller , as described in U.S. Patent No. 3 , 627 , 679 in subpart 1 , lines 48 through 50 Fuller states the need for biologic treatment of pulp and paper mill effluent has forced the art to include effluent disposal systems of greater or lesser efficacy as an almost integral part of a pulp and paper mill complex.

As in Siefert , et al , as described in U.S. Patent No. 5 , 200 , 089 in subpart 1 , lines 49 through 54 Siefert , et al , states the following: Once the suspended solids have been precipitated in basin 3 , the effluent stream moves through channel 5 intobio-degradation basins 7 and 9 . The pH of the stream entering the

bio-degradation basins 7 and 9 must be between pH 7 and 8 in order to prevent damage to micro-organisms in the basins.

As in Ackel , as described in U.S. Patent No. 4 , 738 , 750 in subpart 3 , lines 30 through 32Ackel states the following: , and then on to be biologically treated 16 to remove BOD. Such biological treatment and the methods of biological treatment are well known in the art . However , as discussed and described later in this invention that there is actually no biological treatment , no biological degradation , no bugs degradingorganics . Additionally , that the Biochemical Oxygen Demand test for these pulp and paper mill wastewater has some severe loop-holes and is detrimental to environment and water quality . Furthermore that U.S. EPA must in order to protect human health , aquatic life , stream water quality and stream water quality standards must immediately revoke all pulp and paper mills National Pollutant Discharge Elimination Permits (NPDES) and reissue with Chemical Oxygen Demand limits and additionally with Monitor and Report for Total Organic Carbon and Color limits.

As in Lind , et al , as described in U.S. Patent No. 5 , 766 , 485 in subpart 1 , lines 37 through 40Lind , et al , states the following: Suspended solids can be readily removed and organic materials that use up oxygen , that is , that have a high biochemical oxygen demand (BOD) , can also be generally removed using existing technologies . Again as stated in comments in Ackel U. S. Patent in above paragraph Lind was also not aware of severe problems with secondary biological treatment in these pulp and paper mills' wastewater and the criminal loop-holes in Biochemical Oxygen Demand test.

As noted in Lind , et al , as described in U.S. Patent No. 5 , 766 , 485 inventor points out that Fuller process has not been adopted widely because of three reasons. InLind ,et al , alum process residues (APR) were used to remove colored contaminants ; howeverLind as well as Fuller ,Siefert , et al , Newton , andAckel all considered that secondary biological aeration treatment could not be eliminated. And as well this was stated and known art of treatment in pulp and paper mills wastewater. The basic premise was that just as when I joined Boise' s Deridder Mill the wastewater discharged even though it has a Color concentration of 3000 to 5000 milligrams per liter , there's nothing harmful in wastewater and it would cost millions of dollars to clean the wastewater. Thus , basic premise is it is too expensive , and secondary biological treatment is satisfactory. Thus , I was told if we now spend $5,000, 000 for biological treatment ; it is not economically feasible to spend another $5,000,000 for Color Removal. Therefore , the real reason thatLind , Fuller , Newton ,Ackel , nor Siefert methods have been instituted is that industry has convinced EPA regulatory agency Color is not harmful and secondary biological aeration treatment is satisfactory . However , with this said invention the demonstration of the facts and the fact that it is revealed of the non-degradation in biological treatment in 800 to 1000 milligrams per liter Chemical Oxygen Demand , the 300 to 600 milligrams per liter Total Organic Carbon , and the 2500 to 4500 milligrams per liter Color are being discharged at Boise and Bowater's mill atCatawba , South Carolina ,

and International Paper's mill at Georgetown , S. C. . Therefore as well as all the other + 900 integrated pulp and paper mills in U. S. there is no biological degradation taking place in the aerated stabilization basins , activated sludge , and other aeration systems.

Additionally, other prior art did not discuss nor fully evaluate Chemical Oxygen Demand and Total Organic Carbon concentrations as it was assumed by them that these were reduced in secondary biological aeration ; however this is false . Conventional early treatment processes such as precipitation of the suspended solids with lime , polyelectrolyte polymers or inorganic metallic salts are effective in removing some color from such effluent. Somepolyelectrolyte polymers at high dosage rates are prohibitively expensive and technically unfeasible for treating large quantities of wastewater generated by commercial -size pulp and paper plants. Inorganic metallic salts produce a great deal of sludge ; however when secondary biological aeration treatment is eliminated with the cost savings in electrical aerators and maintenance are realized then the extra amount of sludge becomes a minor factor . And in this invention burning thedewatered solids in existing combination bark/oil/gas/coal fired boilers industry gets a credit and award for the energy , BTU content of thedewatered solids. Furthermore , the reduction and high removal efficiencies for Chemical Oxygen Demand and Total Organic Carbon across the primaryclarifiers renders this technology to be very cost - effective.

In Fuller process , U. S. Patent # 3, 627, 679 , subpart 1 , lines 48-50 , inventor states there is need and requirement for biologic treatment. Thus, Fuller as other old art were not aware that secondary biological treatment was not required and was not working because of the loop-hole in Biochemical Demand Test . That EPA was only requiring BOD test was and is a flagrant failure . Fuller also states in subpart 2, lines 14 through 16 , which effluent is discharged (usually passing to further treatment such as conventionalbiooxidation disposal system.)

3. Process For Color Removal From Paper Mill Wastewater And Discussion of Relevant Patents

Treating pulp-and-paper mill streams

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a. United States Patent 4,201,666
Newton May 6, 1980

Treating pulpand-paper mill streams

Abstract

Aqueous pulp-and-paper mill waste streams are treated with a waste stream derived from the nitric acid etching of aluminum foil for electrolytic capacitors. This waste stream consists essentially of aqueous acidic aluminum nitrate, and a polyelectrolyte is added to it to synergistically improve flocculation, settling, and dosage rates.

Inventors: Newton; Joel A. (Greensboro, NC)

Assignee: Sprague Electric Company (North Adams, MA)

Appl. No.: 032052Filed: April 23, 1979

U.S. Class:210/47; 210/52; 162/29

Intern'l Class: C02B 001/20; D21F 001/82

Field of Search: 162/4,29,79 210/42 R,47,51-54

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Attorney, Agent or Firm:Connolly and Hutz

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b. United States Patent 5,529,697
Braasch, et al. June 25, 1996

Abstract

Potassium permanganate is added to paper mill wastewater streams at an elevated temperature to remove color compounds from the effluent streams. The potassium permanganate causes the formation offlocculant particles which are precipitated out of the stream. This precipitate is then treated with acid to cause resolubilization.

Inventors:Braasch; Dwaine A.</B> (Hattiesburg, MS);<B>Ellender; R. D.</B> (Hattiesburg, MS)

Assignee: The University of Southern Mississippi</B> (Hattiesburg, MS)

Appl. No.: 278017

Filed: July 20,1994

U.S. Class: 210/710</B>; 162/189; 210/721; 210/724; 210/737; 210/758; 210/760; 210/766; 210/917; 210/919; 210/928

Intern'l Class: C02F 001/52

Field of Search: 162/189

210/721,724,726,737,752,758,759,760,766,917,928,710,919

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5326479	Jul., 1994	Sarker et al.	210/928.

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c. United States Patent 4,738,750

Ackel , April 19, 1988

Abstract

(See attached Patent # 4, 738, 750)

Inventor: CharlesAckel ,Norcross , Georgia

Assignee: Stone Container Corporation , Chicago , Illinois

Filed: Febraury 10 , 1986

U.S. Class: **162/29** ; 162/31 ; 162 /189 ; 210/631 ; 210/703 ; 210/704 ; 210/705 ; 210/711 ; 210/769 ; 210/928

Field of Search: 162/29 , 31 , 47 , 190 , 162/189 , 423/DIG . 13 ; 210/928 , 729 , 703 , 712 , 704 , 758 , 705 , 711 , 631 , 769 ; 422/185

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d. United States Patent 5,766,485

Lind et al ., June 16, 1988

Abstract

Alum processresidues (APR) are used to remove colored contaminants from waste waters. In addition , in accordance with the invention , up to 0.1 % by weight of alum and up to ppm of a polyelectrolyte is added to improve color removal ,turbidity removal and the settling rate. The resultant APR-alum-polymer mixture together with contaminants in the waste water settles rapidly , reducing the costs of color removal process.

Inventors: Christopher Bruce Lind , Syracuse ;

David Kisling Kennedy ,Constantia , both of New York

Assignee: General Chemical Corporation Parsippany, New Jersey

Filed: June 6, 1995

U.S. Class: **210/711** ; 210/725 ; 210 /727 ; 210/734 ; 210/917 ; 210/928 ; 162/189 ;

Field of Search: 210/711, 725 , 210/727, 728, 734, 917, 928 ; 162/189, 190

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e. United States Patent 5,200,089

Siefert et al., April 6, 1993

Abstract

The invention provides a method for decolorizing an effluent stream from a pulp mill plant comprising the step of adding an effective amount of a decolorizing composition including a ferrous sulfate and a water-soluble cationic amine polymer.

Inventors: Kristine S. Siefert, Crete ;
Manian Ramesh, Naperville ; Martha Finck, Countryside ;
Chandrashekar S. Shetty, Lisle, all of Illinois

Assignee: Nalco Chemical Company Naperville, Illinois

Filed: August 12, 1991

U.S. Class: **210/725** ; 210/728 ; 210 /736 ; 210/917 ; 210/928

Field of Search: 210/725, 727 , 728, 735, 210/736, 917, 928

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f. United States Patent 3,627,679

Robert R. Fuller , December 14, 1971

Abstract

A waste effluent treatment which involves contacting a waste effluent , e. g. pulp and paper mill effluent , with a metal salt reagent , preferably alum mud . Treatment decolorizes the effluent and precipitates a substancial portion of the organic content . The precipitate and sludge is dewatered , then calcined , and the reagent regenerated from the ash again in a cyclic process .

Inventors: Robert B. Fuller Tuscaloosa , Alabama

Assignee: Gulf States Paper Corporation Tuscaloosa , Alabama

Filed: May 25 , 1967

U.S. Class: **210/45** ; 162/29 ; 210 /47 ; 210/52

Field of Search: 210/45 , 47 , 52 ; 162/29

SUMMARY OF THE INVENTION

The invention obtains the above objects and advantages by providing raw influent treatment process eliminating secondary biological treatment and generating resultant cost savings to operators by eliminating aerators' horsepower and maintenance . This results in direct economic electrical energy savings to U.S. Pulp and Paper industry . Specific and preferred embodiment of invention provides that in existing biooxidation treatment in existing pulp and paper mills there is really no biodegredation and no reduction in organics , Chemical Oxygen Demand , Total Organic Carbon , and Color in the secondary biological aeration systems . This raw influent treatment process provides for adding chemicals at combined influent in primary clarifier and eliminating secondary aeration biological treatment. In one preferred embodiment of the invention , optimum control and removal efficiencies for said Chemical Oxygen Demand , Total Organic Carbon , and Color are instituted by a continuous in-line pH controller of addition of said reagent chemicals which controls the large volumes of raw influent flow to a set pH of 5.7 to 6.0 . According to a further preferred embodiment , the monitoring and

controlling the Color , Chemical Oxygen Demand , and Total Organic Carbon removal efficiencies across the primary clarifier(s) are enhanced by insertion of Continuous in-line Chemical Oxygen Demand Analyzer at outlet of primary clarifier(s) . The most preferred embodiment is that the automatic control of reagent chemicals by the Automatic pH Controller obtains 90-95% Biochemical Oxygen Demand , 90-95% Chemical Oxygen Demand , 90-95% Total Organic Carbon and 90-95% Color removal efficiencies across the primary clarifiers . As proven in Boise Southern 's DeRidder wastewater , and additionally from SCDHEC files the 795 milligrams per liter Chemical Oxygen Demand , the 368 milligrams per liter Total Organic Carbon , and the 2820 milligrams per liter Color presently being discharged by Bowater , Catawba , South Carolina , mill would all be reduced to high effluent quality of 45 milligrams per liter Chemical Oxygen Demand , 40-60 milligrams per liter Total Organic Carbon , 150 to 300 milligrams per liter Color (measured Platinum -Cobalt units) and 25 to 45 milligrams per liter of BOD.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

List of all Figures are as follows:

Figure 1 is schematic flow sheet showing the various stages of present raw influent treatment process.

Figure 2 is schematic flow diagram depicting the Existing conventional biological treatment and inherent fraudulent deficiencies in the Biochemical Oxygen Demand test ; and the flow sheet demonstrates the associated high COD , TOC, and Color concentrations discharged to streams , navigable waters .

Figure 3 is schematic flow diagram depicting with this invention " Raw Influent Treatment Processes Eliminating Secondary Biological Treatment " and which demonstrates the improved low BOD , COD , TOC , and Color concentrations with absolute elimination of secondary biological treatment.

Table 1 demonstrates the chemical analyses of raw influent of Boise Southern Company's ,DeRidder Louisiana , mill and the preferred embodiments of proposed invention of this raw influent treatment processes.

Table 2 demonstrates actual discharges the from South Carolina Department of Health and Environmental Control actual files for NPDES Permitted wastewater discharges of Bowater atCatawba , South Carolina NPDES Permit # SC0001015 ; and International Paper at Georgetown , South Carolina , NPDES Permit # SC0000868 .

DETAILED DESCRIPTION OF THE INVENTION

"DESCRIPTION OF THE PREFERRED EMBODIMENT"

Main contention of the pulp and paper industry was Color removal by excess lime treatment and other chemicals would cost millions of dollars per year and any other Color technology process was not technically justified as it would be cost prohibitive! However , this is a falsehood that this invention reveals. Raw influent wastewater from pulp and paper mills are very high colored (Color concentrations in range of 2500 milligrams per liter to 5000 milligrams per liter) and high in Chemical Oxygen Demand and Total Organic Carbon materials .

In a first step , the raw influent process sewer flows through line **1** into flash mixer **20** and are stirred , flash mixed together sequentially with Alum solution , and mixed with cationic or anionic polymer to absorb the color forming and organic bodies in the raw influent wastewater . The chemicals liquid commercial Alum solution is automatically controlled by automatic feedback from line **2** feeding into automatic in-line pH controller **30** . After mixing in flash mixer for a few minutes residence time , the flow is transferred continuously through the in-line automatic pH controller in line **2** and exiting the in-line automatic pH controller in line **3** to primary clarifier **40** . In the primary clarifier the solids are further coagulated , agglomerated and settled out of solution . As in other known water treatment and wastewater treatment the addition of cationic or anionic polymer increases the settling rate and eventual ease of thickening in order to produce higher dewatered solids going to bark pile storage. It thus also increases the BTU content of the dewatered sludge. The clarified supernatant from which the color bodies have been removed can be decanted through line **4** after specified settling time in clarifier design. At this supernatant discharge in line **4** from the primary clarifier , the Color has been reduced approximately by 90% to 98% to average Color of 200 to 300 milligrams per liter . The supernatant is continuously analyzed by automatic in-line Chemical Oxygen Demand Analyzer , (COD) **50** .

The solids remaining in the primary clarifier undeflow tank bottom are recovered through line **7** and thickened in an inclined lamella (Trademark) or similar thickener /settler **60** to remove more water increasing per cent solids consistency . This water is removed through line **8** and is recycled back to mixer **20** . The solids are further dewatered , as with standard commercially available belt presses **70** , to concentrate the solids further to approximately 25 percent to 35 percent . Water is drawn off in line **9** and recycled back to the inclined thickener **60**. The fully dewatered solids can be conveyed from the belt presses via belt conveyor **10** onto the

existing bark storage **80** . The dewatered solids do have some BTU content and are mixed with existing bark and wood residues as they are conveyed from bark storage **80** to the existing power boilers via conveyor **11** ; thus dewatered solids are regenerated by burning in existing combination bark /oil/coal firedboliers **90** .

The ash remaining from existing existing combination bark /oil/coal fired boliers **90** is recycled back to raw influent process sewer through line **12** back to mixer **20** . Through this line **12** the recovered aluminum metal ions are resolubilized and tied back into raw influent process line **1** reentering mixer . Because of some of ash content is inerts , Calcium , Magnesium , Silica and other inerts (such as at Boise's DeRidder mill the inerts averaged approximately 20 percent) , approximately 20 percent to 35 percent inerts are wasted to non-hazardous landfill through line **13** .

Based on the test results approximately 65 percent of recovered aluminum is available for re-use and for flocculation in line **1** and approximately 35 % of new commercial Alum solution reagent would be added through reagent line **14**.

Normally only one polymer utilizing a dosage rate of 0.25 to 3.00 parts per million is used in the mixer along with the liquid alum solution . This is normally an anionic , but cationic or non-ionic in varying dosages rates may also be required with various concentrations. Polymer either cationic , anionic or non-ionic are added through line **15** to further increase solids consistency and concentration in inclined thickener **60**.

The supernatant after passing through the in-line Chemical Oxygen Demand Analyzer **50** passes through line **5** onto final polishing tank or in most cases will pass through existing ASB's , aeration systems with aerators turned off. The supernatant will buffer on all occasions back up to pH of 6.5 to 7.5 because of the carbonate pick-up and available sodium ions in solution . (This was actually proven in 30 days trial at Boise's mill with full plant flow of 30 million gallons per day of Alum treatment at primary clarifier ; and with 23 days retention in Boise's ASB 's the outlet pH was 7.5 .) However, just as emergency safeguard in case Total Suspended Solids , TSS , or pH need to be adjusted this final polishing tank **100** is added prior to final discharge in line **6** exiting the final polishing tank.

The invention will be further illustrated in following Table 1 and Table 2 as inventor performed approximately 280 chemical analyses / statistical technical feasibility evaluation on Boise's DeRidder , Louisiana , raw influent to effectively determine feasibility and economics. In examples the raw influent wastewater was controlled to a pH of 5.7 to 6.0 . Analytical Analyses performed on the raw influent samples and treated effluent after chemical treatment included pH , BOD , COD , Total Organic Carbon , and Color .

In Table 1 the raw influent wastewater trials are shown. Each wastewater sample was characterized by some or all of the following analyses : pH - measured with a combination glass /reference electrode ; True Color -measured by the NCASI method using a HACH DR2000 spectrophotometer ; Biochemical Oxygen

Demand -5 day test as by *Standard Methods for Examination of Water and Wastewater ;* Chemical Oxygen Demand , COD , and Total Organic Carbon by same *Standard Methods for Examination of Water and Wastewater.*

One of the most very vital initial portions of the laboratory scale investigations was to try to find an economical technical means and method for removal of Color , BOD , COD , and TOC resulting in over 90% of Color reduction . For the basic premise for which U.S. EPA , states regulatory agencies , and top line management at the pulp and paper companies rely on is as follows: *" If we are spending $5,000,000 now for secondary biological treatment , then in no way can we justify spending another $5,000,000 for Color removal alone , as Color is not harmful and is only of aesthetic concern. " However, I discovered in the discovery of my invention this is false and there in no biological degradation , no biological destruction taking place in secondary aeration treatment. Thus this inventor does have an economical technical feasible alternative! "* And this is why I elected to perform all lab scale jar stirrer investigations and utilize all parameters BOD , COD , TOC , Color , pH and fully investigate mechanisms. You see even one high officer at Temple Inland Paper Mill at Evadale , Texas , held a news conference and drank some of the wastewater to try to demonstrate that just because the pulp and paper mill wastewater had a high Color " there was nothing harmful in this wastewater!" Well , pity this not very knowledgeable corporate officer ; the real truth involves a little more depth than that . As if you can add chemicals at the raw influent at primary clarifier and immediately reduce the BOD from 250 milligrams per liter to 45 milligrams per liter and subsequently reduce COD , TOC , and Color by 90% to 95% , real question is secondary biological treatment doing anything ? Answer is NO. As you can deduct from Table 2 , such as in Bowater's wastewater the COD , TOC , and Color exiting the primary clarifier are 795 milligrams per liter Chemical Oxygen Demand , 368 milligrams per liter of Total Organic Carbon , 2820 milligrams per liter of Color . And those are same concentrations in raw influent , exiting aerated basins , secondary treatment ; there is no biodegradation . Thus EPA 's use of the Biochemical Demand Test (5 day test) as only analytical parameter in measuring toxics , organics is grossly flawed . Thus , I am not positive without conducting further detailed investigations , but I believe that the lignins , lignin degradation products , humic acids , sulphates(ites) attached to ring structures , and cellulose fibers are negatively charged during the pulping /paper making processes . It is these charges that are measured at the raw influent . And as soon as you remove these lignins , and other ringed organics the BOD , COD , TOC , and COLOR are all reduced respectively. I believe that through the aeration , activated sludge somehow the lignins are neutralized to a neutral charge , but are not biodegraded. Even as you see in Boise , Bowater , International Paper and all other +940 pulp and paper mills the COD is >800 milligrams per liter , TOC is > greater than 350 milligrams per liter , and Color is greater than 2500 milligrams per liter .

For as you can see in Table 2 from South Carolina Department of Health and Environmental Control actual files , Table 2 , demonstrates that Bowater's mill at Catawba , South Carolina , is discharging a wastewater with 795 milligrams per liter Chemical Oxygen Demand , 368 milligrams per liter of Total Organic Carbon , 2820 milligrams per liter of Color , and 88 milligrams per liter Biochemical Oxygen Demand concentrations . Additionally, International Paper 's mill at Georgetown , South Carolina , is discharging a wastewater with 708 milligrams per liter Chemical Oxygen Demand , 244 milligrams per liter of Total Organic Carbon , 1783 milligrams per liter of Color , and 149 milligrams per liter Biological Oxygen Demand concentrations .

The trials 1 -10 listed in Table 1 below were all conducted as follows: A standard gang / jar stirrer assembly with lighted background with capacity of four individual beakers with capacity of 1000 milliliters each of liquid capacity were used . The gang/jar stirrer assembly had individual mechanical stirrers installed from top and had power control to control the mixing speeds to very slow to optimum fast as to duplicate mixing in commercial on-line flash mixing tanks. First two beakers were raw influent control . And to the second two beakers the controlled liquid commercial alum solution was added and controlled to set pH range of 5.7 to 6.0 . After adding the said liquid alum down to pH range of 5.7 to 6.0 , the mixtures in beakers three and four were fast mixed for up to thirty seconds . Then to beaker number three a selected amount of cationic polymer was added . And to beaker number four a selected amount of anionic polymer was added . Afterward all four gang stirrers were continuously stirred for several more minutes at slow mixing speed to allow full coagulation , agglomeration , and full building of flocculation particles . Then the gang stirrers were turned off as mixing was stopped and solids were allowed to settle .

At end of settling time the supernatant's final pH was measured , the dosage rates of liquid Alum calculated , BOD , COD , TOC and Color were performed on supernatant of the treated supernatant in beakers 3 and 4 . Same identical analyses were performed on the raw influent control beakers 1 and 2. A pipet or syringe was used to transfer supernatant . An additional item found during this 2 ½ year investigation is that lime treatment at higher pH's and treatment at lower pH's (lower acid in the pH range of 1 to 3.5) did not show as high removal efficiencies. This was because materials are amphoteric as they re-dissolve in lower pH and higher pH ranges. As noted in Braasch et al , as described in U.S. Patent No. 5 , 529 , 697 in page 5 , lines 4 through 8 inventor points out " The precipitate 18 is removed from retention basin 16 thru line 26 and is further treated with acid in chamber 28 to cause solubilization .

Alum is liquid commercially available solution which is an aluminum sulfate (commercial liquid solution) [Al .sub .2 (SO.sub.4).sub.3] . This liquid Alum solution is available from many commercial manufacturers such as General Chemical , Van Waters and Rogers Chemical Corporation , American

Cyanamid , and others . Approximate bulk cost of the liquid alum solution is $125 per ton based on dry basis.

Aluminum chloride [Al . Cl . sub.3] is commercial grade liquid solution of aluminum chloride . The aluminum chloride also performs as well as the liquid Alum solution.

Ferric Chloride which is liquid solution [FeCl.sub.3]; and Ferric Sulfate which is liquid solution [Fe.sub.2 (SO.sub.4).sub3] also may be utilized with similar COD , TOC , and Color removal efficiencies. Ferrous Sulfate which can be purchased in bulk in dry and solubilized in storage tank and fed via the continuous in-line pH controller to the optimum pH at 5.7 to 6.0 as with all other chemicals described and claimed. [Fe. (SO.sub.4). 7 ½ H2O] .

The technical process and removal efficiencies are the same for Aluminum chloride [AlCl . sub.3] ; ferric chloride ; ferrous sulfate ; ferrous sulfate and sulfuric acid ; barium chloride and hydrochloric acid ; and barium sulfide , borax and sodium silicate mixtures as detailed in claims . Overall operating costs will vary with the uses of the other reagents described in this paragraph . Probably the commercial alum liquid solution would be most economical as this liquid commercial alum solution is utilized in paper machines head box and fiber mixing chambers prior to flowing onto paper machine screens moving at high speeds up to 3500 feet per minute.